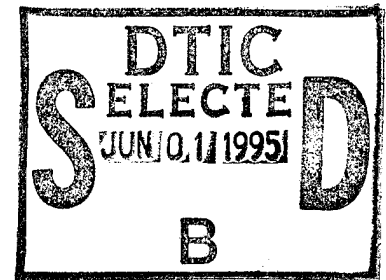


NAVAL POSTGRADUATE SCHOOL MONTEREY, CALIFORNIA



THESIS

**A CHANGE IN THE NAVY'S DRUG TESTING
POLICY: HOW WILL IT AFFECT COSTS AND
THE PROBABILITY OF DETECTING DRUG
USERS?**

by

John R. Jones

March 1995

Principal Advisor:
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Lieutenant, United States Navy
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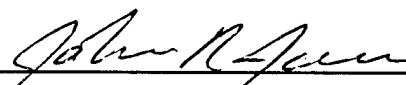
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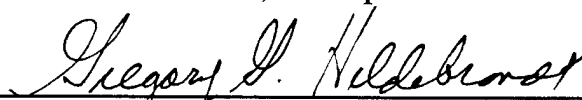
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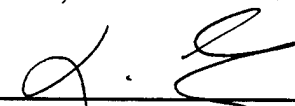

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ABSTRACT

This thesis analyzes changes in the Navy's drug testing policy as they relate to costs and the probability of detecting a gaming or non-gaming drug user. Additionally, this thesis considers actual command level testing policies; showing how a policy change would affect the commands' probability of detecting a drug user. The Navy's zero tolerance policy for drug use has significantly reduced drug use within the Navy. This zero tolerance policy is primarily enforced with the drug testing program. Great leeway is given to commanding officers in their enforcement of this policy. Results from the Worldwide Survey have shown that drug abuse remains a problem for junior enlisted. Self reported drug use in the past year for junior enlisted is 17 percent. But, urinalysis results do not reflect this high value. Probability models, developed by NPRDC and a total costs model described in this thesis, show that a simple change in the manner in which drug testing is conducted will reduce drug use, minimize the costs of drug use to the Navy and decrease the amount of time till a drug abuser is detected.

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I. INTRODUCTION

A. BACKGROUND

The Navy's zero tolerance policy for drug use is one of the factors that has significantly reduced drug use within the Navy (Bray, 1992). This policy has evolved for over 20 years (Biegel, 1979). It is primarily enforced through urinalysis testing. Currently, the policy states each command will test no more than 20 percent of their personnel on a monthly basis (OPNAV 5350.4b, 1990). Under this policy, great leeway is given to each commanding officer as to the rate and timing of drug tests. As long as the criteria of less than 20 percent is met, the command is considered to be within the testing guidelines. By allowing such a high degree of latitude and by not furnishing additional guidance concerning the testing policy, the Navy may reduce the probability of detecting a drug user and increase the total cost of drug use to the Navy. It is time for the Navy to consider redefining its policy toward drug testing.

1. Testing Policies

The results of the five Worldwide Surveys given since 1980 show that drug use within the Navy has dramatically decreased (Bray, 1992). This sharp reduction can be traced to the urinalysis testing program. Due to numerous factors, discussed in Chapter II, illegal drug use within the lower enlisted pay grades continues at a relatively high level (Bray, 1992). If the usage rate indicated in the Worldwide Survey is accurate, a more clearly defined drug testing program would be helpful.

For example, consider two commands. One command tests 20 percent of their personnel on the first Monday of the month. The other command tests five percent every Wednesday (up to a total of 20 percent). Both of these examples meet the OPNAV requirement for testing. But, drug abusers can easily circumvent these two testing procedures. Drug abusers can use drugs on the day following

the urinalysis. Odds are the drug will not be in their urine on the next test day (NDSL, 1994). This thesis focuses on the change in the probability of detection due to alternate testing policies.

2. Total Cost of Drug Use to the Navy

The total cost to the Navy of retaining a drug user is difficult to measure and beyond the scope of this thesis. But, a Total Cost of Drugs Model (TCD) can be used to determine the relative cost of drug use and the optimum level of drug testing to minimize the total cost of drug use (Gates, 1994). By holding other variables constant, the optimum level of drug testing can be determined.

B. RESEARCH QUESTION AND METHODOLOGY

The primary research question is: "How will changes in the Navy's Drug Testing Policy affect the probability of detecting a random drug user, a gaming drug user or both?" Additional research questions include: "How will the total cost of drug use be affected by changing the drug testing policy?" and "How would proposed policy changes affect actual command level testing policies?"

There are numerous components in the TCD Model equation that have not been specifically defined. Therefore, constant approximations for these components are used. This thesis is concerned with the level of drug testing that minimizes the Navy's total cost of drug abuse. The level of testing that minimizes the Navy's total cost of drug abuse is an approximation relative to the constant components of the model. These relative values are determined using the testing level results found in the Naval Personnel Research Development Command's (NPRDC) data bases.

The Naval Personnel Research Development Command has developed two data bases: DPAS - Drug Policy Analysis System and DIPM - Drug Information Presentation Manager.

1. Drug Policy Analysis System (DPAS)

The primary research question is addressed in Chapter III using the DPAS program. The DPAS program is used to determine the change in the probability of detection from implementing different testing procedures. This program allows a variety of drug testing policies and personal drug use patterns to be imputed. These data points can be combined with the TCD Model to determine the optimum level of drug testing.

2. Drug Information Presentation Manager (DIPM)

The secondary research question concerning command level policies is addressed in Chapter IV using the DIPM data base. The DIPM program is used to determine a specific command's probability of detection using that command's testing policy. The probability of detection for actual testing policies can easily be compared to the probability of detection for alternate testing policies.

3. Total Cost of Drug Use Model (TCD)

The TCD Model will be used in Chapter IV to illustrate how testing policy, and the level of drug testing affect the Navy's total cost of drug abuse. Conclusions and recommendations are given in Chapter V.

II. BACKGROUND

To better understand the Navy's drug testing policy and how changing that policy will affect the Navy's drug use cost, it is important to develop a background on these issues. This chapter will address the history of the Navy's drug testing policy and reported drug use within the Navy.

A. HISTORY OF THE NAVY'S DRUG TESTING POLICY

1. Early Years

The birth of the Department of Defense's drug testing policy can be traced to the summer of 1971 (Biegel, 1979). This new policy was part of President Nixon's worldwide program of identifying and treating drug abusers (Biegel, 1979). DoD officials believed drug users could be rehabilitated and returned to full duty (Bray, Marsden, 1992). This random urinalysis program was thought to be successful in reducing the number of drug users within the military. At this point in time, the results of a urinalysis test were not used in punitive actions. Therefore, it was thought that users would be more inclined to seek assistance and rehabilitation (Doster, Ross, 1993). In 1974, although not initially intended to be used as evidence in administrative or punitive proceedings, test results were being used in Uniform Code of Military Justice (UCMJ) actions (Biegel, 1979).

Within two years, researchers from the Human Resources Research Organization (HRRO) discovered a major difference between levels of drug use indicated by the urinalysis program and reported by anonymous surveys (Reaser et al, 1975). The HRRO study also found that the drug testing program was not a restraint to those individuals inclined to abuse drugs. Although, HRRO suggested numerous recommendations for changing the urinalysis program, none were ever implemented. (Reaser, 1975)

In July 1974, a Military Court of Appeals required DoD to stop using urinalysis if the specimen could be used in punitive actions or administrative

separations. For the next six years, the drug urinalysis program was used only to determine the need for drug rehabilitation (Doster, Ross, 1993). In 1980, as suddenly as the Military Court of Appeals had stopped the drug testing policy, the Court of Appeals reversed its decision and cleared the path for implementing a urinalysis program, used both as a deterrent and evidence gathering device (Lieb, 1986).

2. Current Policy

a. DoD Directive 1010.4

In August of 1980, the Department of Defense published DoD Directive 1010.4. The stated purpose of this directive was to define the Department of Defense's drug abuse policy and standards. A number of policies were set forth dealing with alcohol and drug abuse. A stated goal of the directive was to free DoD from the ill effects of drug abuse. This thesis is concerned only with the policies that specifically address drug use. They are:

- Assess the alcohol and drug abuse...influencing the Department of Defense.
- Not induct persons into the Military Services who are alcohol or drug dependent...
- Deter and detect alcohol and drug abuse within the Armed Forces...
- Provide continuing education and training...to alleviate problems associated with alcohol and drug abuse.
- Treat or counsel alcohol and drug abusers and rehabilitate the maximum feasible number of them. (DoD 1010.4, 1980)

This directive also required the Secretaries of each service to establish and operate programs that supported the new DoD policy. In light of this attitude and the legal position concerning drug testing, the DoD issued a new directive addressing drug testing.

b. DoD Directive 1010.1

The DoD's new drug testing program, issued in 1980, was set forth in DoD Directive 1010.1. The drug testing policy is:

- Preserve the health of members of the Military Services by identifying drug abusers in order to provide appropriate counseling, rehabilitation, or other medical treatment.
- Permit commanders to assess the security, military fitness, and good order and discipline of their commands, and to take appropriate action based upon such an assessment. (DoD 1010.1, 1980)

The directive lists guidelines and limitations to using urinalysis results. This directive clearly states that urinalysis results can be used, with certain restrictions, in punitive or separation proceedings (DoD 1010.1, 1980). This directive lays the foundation for random urinalysis. Armed with these new DoD Directives, the Chief of Naval Operations issued his policy concerning drug abusers.

c. OPNAV Instruction 5350.4B

The OPNAV instruction states that drug abuse or drug use will not be tolerated. The Navy decided that a random urinalysis program would be the most effective manner to discover and deter drug users (OPNAV 5350.4B, 1990). The Department of Labor also recommends using urinalysis to detect and deter drug abuse (DOL, 1990). The first OPNAV instruction, OPNAV 5350.4A, stated that 10-20 percent of the command will be tested on a monthly basis. Regarding the consequences of a positive test, the policy differentiated between pay grades. Only officers and chief petty officers would automatically be processed for administrative discharges. This separation would occur after punitive proceedings were completed. Drug rehabilitation was offered through the Veterans Administration upon discharge. Pay grades E1 through E6 were to be screened and offered rehabilitation if they were deemed treatable. The rehabilitation

treatment would be offered after punitive actions were completed. Upon completion of the rehabilitation program and punitive actions, the individual would be returned to duty. This double standard continued until 1990. (OPNAV 5350.4A, 1986)

The latest version of this instruction was issued on 13 Sep 1990. In its present form, the Navy decided that "zero tolerance" should apply to all pay grades. If illegal drugs are detected during a random urinalysis, the individual will be processed for administrative separation. Again, the discharge occurs after completing punitive proceedings.

The new instruction mandated commanding officers to use the urinalysis testing program. No more than 20 percent of the command can be tested each month unless special permission is given. There are four cases when an authorized urinalysis maybe conducted. They are:

- Inspection. During inspections performed under Military Rule of Evidence 313.
- Search or Seizure. During a search or seizure action...
- As part of one of the following examinations: (a) a command-directed examination or referral of a specific member to determine the member's competency for duty and need for counseling, rehabilitation, or other medical treatment when there is a reasonable suspicion of drug abuse. (b) An examination in conjunction with a service member's participation in a DoD drug treatment or rehabilitation program. (c) An examination regarding a mishap or safety investigation undertaken for the purpose of accident analysis and development of countermeasures.
- Any other examination ordered by medical personnel for a valid medical purpose under M.R.E. 312(f) including emergency medical treatment, periodic physical examinations, and such other medical examinations as are necessary for diagnostic or treatment purposes.
(OPNAV 5350.4B, 1990)

The instruction concerning inspection or random urinalysis procedures continues to give commanding officers great leeway in the timing and nature of the command's urinalysis program. (OPNAV 5350.4B, 1990). This thesis is concerned

with how the probability of detecting a drug user changes as the inspection or random urinalysis pattern is altered. Other uses of the urinalysis program, such as command directed examinations, will not be included in this research.

B. LEVEL OF DRUG ABUSE

1. Worldwide Survey Results and Drug Abuse Trends

a. Methodology

The Worldwide Survey (WWS) sample is a two-stage two phase cluster sample. The first WWS was conducted 1980 by Burt Associates, Inc., of Bethesda, MD., while the last four (1982, 1985, 1988, 1992) were conducted by the Research Triangle Institute (RTI) of Research Triangle Park, NC (Bray, 1992). Both organizations undertook similar statistical approaches to conducting the survey. The population for the survey consisted of active-duty military personnel except recruits, personnel absent without leave, personnel in the service academies and personnel conducting a permanent change of station. Each survey selected approximately 25,000 persons from 63 geographic areas. (Bray, 1992)

The first-stage selected military bases from each of the four services located in four regions of the world. The second-stage selected personnel stationed at these bases from within the pay grades: E1-E4, E5-E6, E7-E9, W1-W4, O1-O3, O4-O10. (Bray, 1992)

The first-phase was conducted using team administrators traveling to site locations to explain and administer the survey. The service members were to mail the completed survey to RTI. The second-phase was conducted by mailing the survey to those participants who did not take part in phase one. These surveys were also mailed to RTI. (Bray, 1992)

b. Trends of Drug Abuse

Over the past 14 years there has been a downward trend of self-reported drug abuse. Figure 1 reflects the downward trend for all DoD personnel. The figure is not adjusted for any sociodemographic differences between surveys.

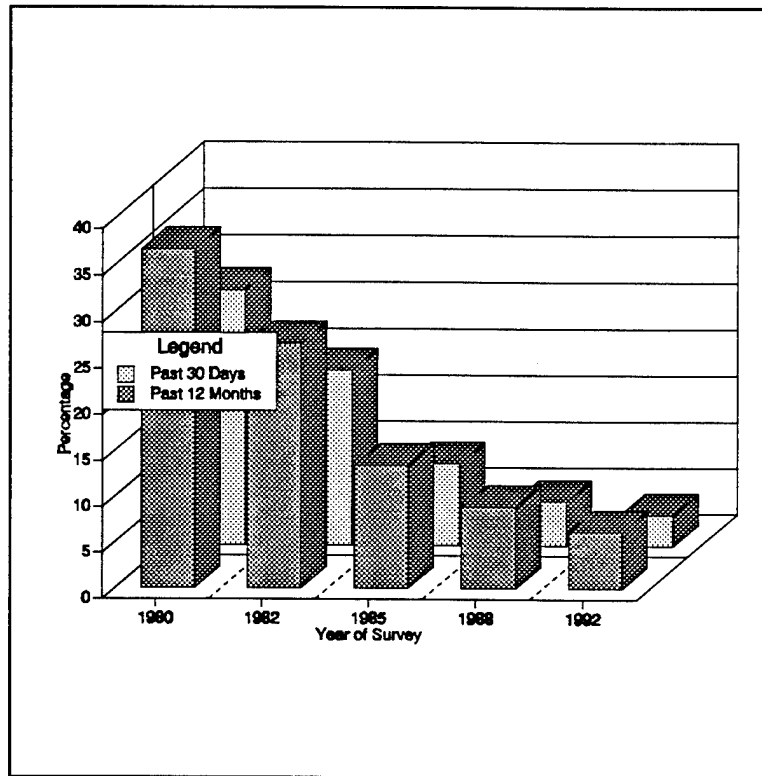


Figure 1 DoD Drug Use After (Bray, 1992)

In 1980, the reported drug use in the past 30 days for all DoD personnel was 27.6 percent. This value decreased to 19, 8.9, 4.8, and 3.4 percent for each of the subsequent surveys. In 1980, the reported drug abuse for the past 12 months was 36.7 percent. This value also decreased over the next four surveys to 26.6, 13.4, 8.9, and 6.2 percent. After adjusting for age, education levels, marital status and pay grade composition the trends remain downward.

Figure 2 reflects the unadjusted and sociodemographic adjusted values for any drug use for all DoD personnel during the past 30 days. The

adjusted values correct for aging of the force, racial composition of the force, rank structure of the force, and marital make-up of the force. The reported drug use rate for the base year of 1980 was 27.6 percent. The adjusted rates fell to 18.2, 9.7,

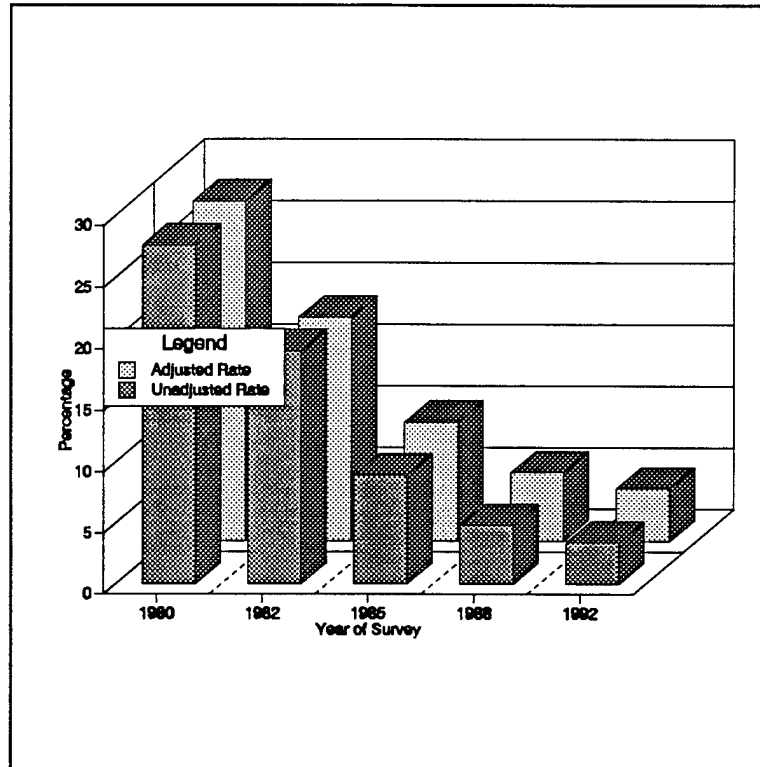


Figure 2 Adjusted and Unadjusted Drug Abuse Rates After (Bray, 1992)

5.6, and 4.3 percent during the follow on surveys. These adjusted rates are similar to the unadjusted rates. The similar rates for the unadjusted and the adjusted figures indicate that drug abuse has been decreasing due to non-sociodemographic factors. (Bray, 1992)

Figure 3 shows the reported rate of drug use Navy wide. This figure reveals that in 1980 self-reported drug use in the past 30 days was 33.7 percent (Bray, 1992). The value is five percent points higher than DoD values for the corresponding survey. The first survey was completed before the Navy implemented its new urinalysis program. The high drug use rate served as a wake-up call to the Navy. Something had to be done to decrease drug abuse.

Each of the following surveys reflected the same downward trend in the Navy as observed in DoD values. In 1982, the use rate dramatically fell to 16.2 percent, which was lower than the DoD wide rate of 19 percent. This decrease was followed by a drop to 10.3 percent in 1985. The drug use rate for the 1982 survey was lower than the DoD values. The following survey results continued to decrease, but Navy drug use remained higher than DoD rates. The next two

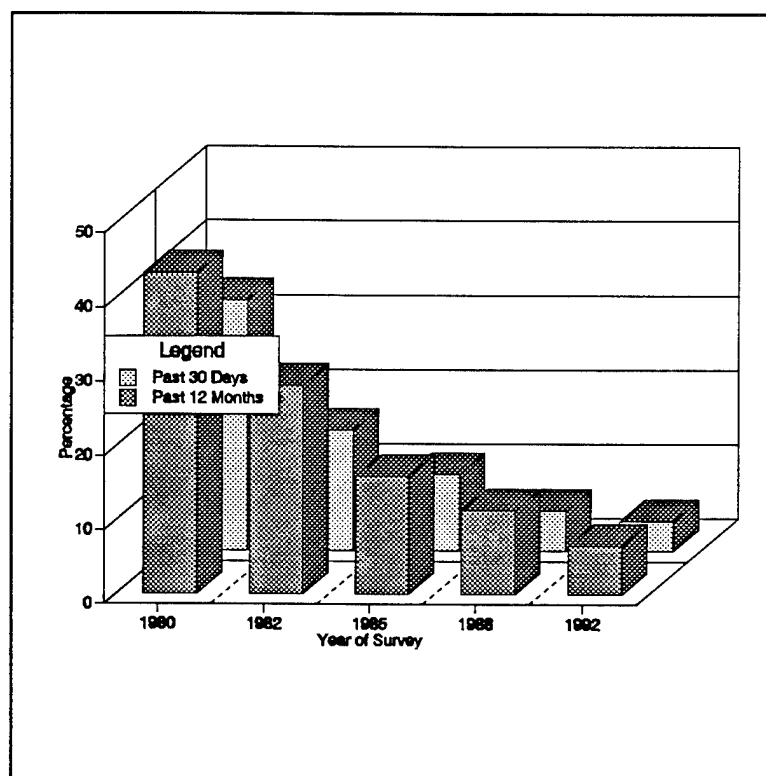


Figure 3 Navy Drug Use After (Bray, 1992)

surveys indicated the drug use rate was 5.4 and 4.0 percent, respectively. These values were not adjusted for sociodemographics. (Bray, 1992)

The Navy's unadjusted drug use over the past 12 months is also found in Figure 3. Again, these values closely followed the DoD's downward trend. The first survey reported any drug use for the past 12 months as 43.2 percent. During the next four surveys the value dropped to 28.1, 15.9, 11.3, and 6.6. (Bray, 1992) These rates are all higher than the corresponding DoD rates. Continued

higher Navy rates as compared to DoD wide rates indicate an improved drug testing program may be beneficial.

The incidence of serious negative effects attributed to drug use is shown in Figure 4.¹ The unadjusted values in this figure follow the same downward trend as the overall drug use rate. In 1980, 17.2 percent of all Navy personnel suffered some serious consequences from drug abuse. This value decreased to 7.4 in 1982, 4.0 in 1985, 2.4 in 1988 and .4 percent in 1992. (Bray, 1992) Although, the 1992 value is less than one percent, it is somewhat misleading. Serious consequences suffered by E1-E3 was 1.7 percent (Bray, 1992). Senior enlisted, E7-E9, reported serious consequences due to drug use at .1 percent. All other ranks reported no significant serious consequences due to drug use (Bray, 1992).

Productivity loss is also reported in Figure 4. In 1980, the reported productivity loss due to drug use was 18.8 percent. This value decreased to 11.3, 3.9, 3.1, and .9 in the follow on surveys. Again, the 1992 survey results are misleading. The reported E1-E3 productivity loss due to drug use is 3.3 percent. Petty Officers, pay grades E4-E6, reported productivity loss due to drug use as .4 percent; senior enlisted productivity loss due to drug use is reported as .1 percent. The officer rates round to zero. Serious consequences and productivity losses, further supporter the benefits for a more clearly defined drug testing policy. (Bray, 1992)

Figure 5 shows the reported drug use in the past 12 months for each pay grade. As the data for the serious consequences suggest, the drug use among lower pay grades is higher. According to the 1992 survey, reported drug use over the past 12 months for E1-E3 is 17.8 percent. Petty Officers, pay grades E4-E6,

¹ Serious Negative Effects are defined as Uniform Code of Military Justice punishment, loss of 3 or more work days, kept from duty one week or more by illness, hurt in accident, spouse left, DWI arrest, incarceration, fights, arrest for drug incident, not getting promoted, and being detoxified.

reported drug use of 4.7 percent. Chief Petty Officers, pay grades E7-E9, reported drug use at 1.5 percent. Warrant Officers reported a use rate of 1.1 percent. Junior Officers, pay grades O1-O3, reported 1.7 percent. The lowest rate of .4 percent was reported by senior officers. (Bray, 1992).

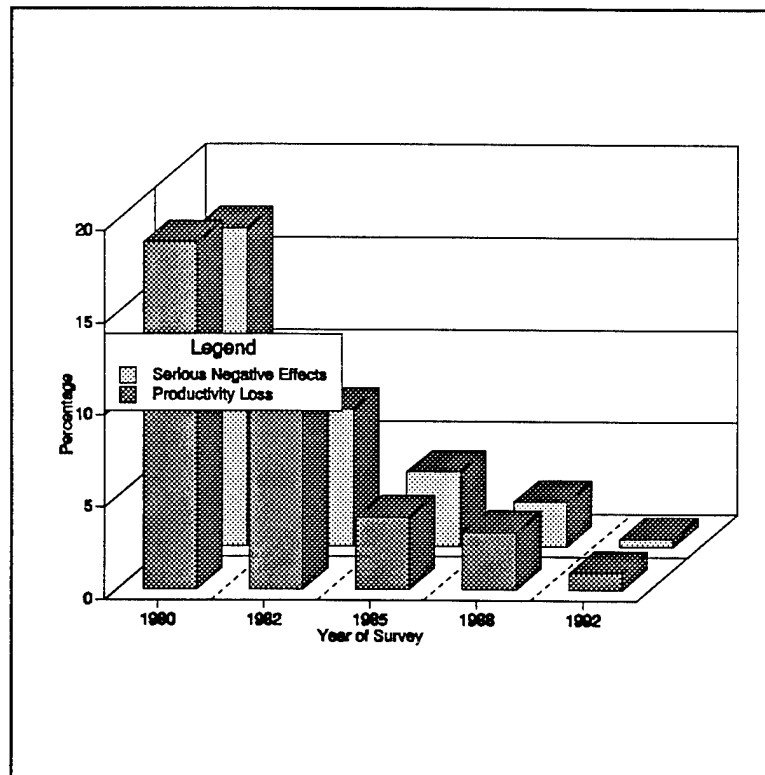


Figure 4 Drug Use Negative Effects After (Bray, 1992)

Figure 6 shows that in 1992, 16.0 percent of all sailors 20 years old and younger indicated they had abused drugs in the past 12 months (Bray, 1992). This value possibly reflects use prior to service, but is consistent with the findings of drug use among lower pay grades. The majority of new enlistees are under the age of 20. Figure 6 contains the values of reported drug abuse by age. As expected, drug abuse decreases with age. Reported use for 21-25 year olds is 10.3 percent, while use reported for those 26-34 is 3.7 percent. The lowest reported rate is 1.5 percent for those personnel over 34 years old.

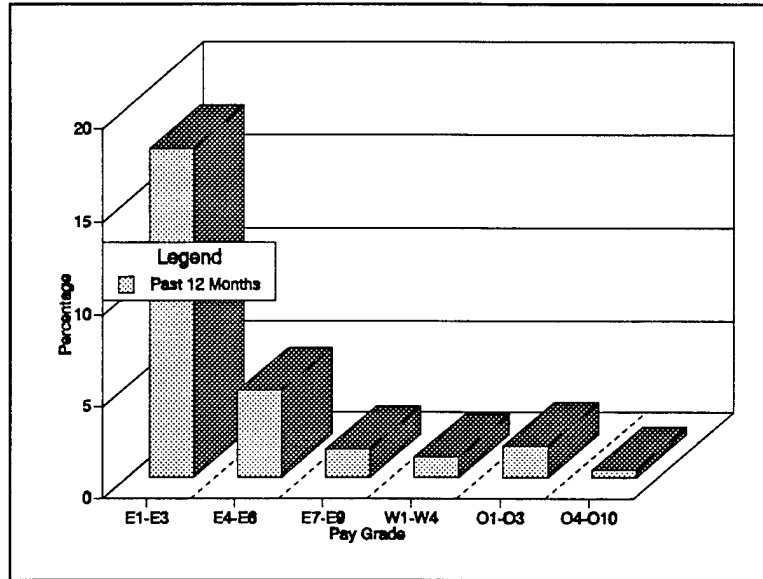


Figure 5 Drug Use By Pay Grade
After (Bray, 1992)

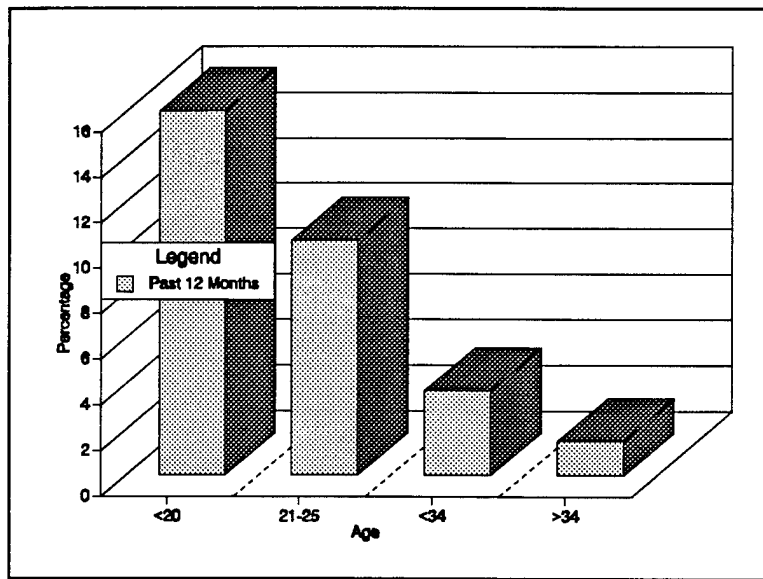


Figure 6 Drug Use By Age
After (Bray, 1992)

Other sociodemographic factors such as sex, race, education levels and family status are shown in Table 1. Males abuse drugs more than females, whites and hispanics abuse drugs more than blacks, non-high school graduates abuse drugs more than college educated personnel and single personnel abuse drugs more than married personnel (Bray, 1992).

2. Urinalysis Testing Program

a. Specimens Tested

The Department of the Navy's OPNAV Instruction 5353.4B establishes the Navy's drug urinalysis testing program (OPNAV 5350.4B, 1990). The Navy operates five drug screening laboratories for forensic urine drug testing (NDSL, 1994). These five laboratories (NDSL) have a testing capacity of 960,000 specimens per year. In FY93, 415,242 samples were tested (NDSL, 1994). This value does not include approximately 700 samples sent to each lab by the DoD Drug Detection and Quality Control Laboratory of the Armed Forces Institute of Pathology (AFIP) (Kuhlman, 1994). A prevalence rate of 1.3 percent positive, or 5347 positive specimens, were detected by the NDSL in 1993. The prevalence rate is found by dividing the total number of positive samples by the total number tested (NDSL, 1994). A prevalence rate of one percent could indicate one percent of the Navy uses drugs one hundred percent of the time or that 10 percent of the Navy uses drugs 10 percent of the time (Thompson, 1992). Therefore, it is difficult to determine if a decline in the prevalence rate indicates a decline in the number of drug abusers or a decline in the amount of time drug users abuse drugs (Thompson, 1992).

b. Quality Control

The Worldwide Survey found that only 57 percent of DoD respondents believed that drug urinalysis testing was accurate. However, the testing procedures themselves are extremely accurate. According to LTC Kuhlman of AFIP, the false positive rate is non-existent. A false positive is defined as a

CHARACTERISTIC	PERCENTAGE
Male	7.6
Female	3.0
White, non-Hispanic	7.6
Black, non-Hispanic	1.7
Hispanic	12.7
Other	3.6
< high school graduate	²
High school grad or GED	8.5
Some College	6.3
College or higher	2.3
Not married	10.6
Married, spouse not present	6.4
Married, spouse present	3.2

Table 1 Drug Use By Sociodemographics

After (Bray, 1992)

² Unreliable estimate.

"report of a drug or metabolite that is not present above the cutoff." (Kuhlman, 1994) The false negative rate is less than two percent. A false negative is defined as a "failure to report a drug or metabolite that is present above the cutoff" (Kuhlman, 1994). The cutoff is defined as the "urine concentration of drug or metabolite which determines the presence or absence of that drug" (Kuhlman, 1994). These figures are supported by the blind quality control and open proficiency test samples sent to each NDSL by the Armed Forces Institute of Pathology.

Urinalysis has proven to be extremely accurate at detecting drugs present above the cutoff levels. However, the urinalysis testing program is unable to detect drugs that are no longer in the system. Table 2 reflects the approximate amount of time that specific drugs remain in the urine (NDSL, 1994). These times are guidelines. Actual detection time will vary with "size of dose, analytical method used, drug metabolism, patient's physical condition, fluid intake, method and frequency of ingestion" (NDSL, 1994).

Table 2 shows that urinalysis may not detect drug use if the test occurs after the detection time has expired. If the normal detection window for a drug is less than five days, a user who consumes the drug on a Friday and is tested on the next Wednesday, will test negative. This sailor and those that knew of the drug abuse may conclude that drug urinalysis testing program is inaccurate. This could help explain why so many personnel believe the urinalysis testing program is inaccurate.

Another perception that leads some to doubt the accuracy of the test is the belief the test can be beaten. According to the NDSL, it is possible to lower the level of drugs in the urine by dilution (NDSL, 1994). Dilution could reduce detectable drugs below the legal cutoff limit, thereby producing a negative urine sample. The NDSL stresses the importance of secrecy in timing the urinalysis; and once announced, speed in implementation is vital.

Drug of Abuse	Detection Time in Urine
MARIJUANA	1-5 DAYS
COCAINE	48 HOURS
AMPHETAMINES	72 HOURS
METHAMPHETAMINE	72 HOURS
CODEINE	48 HOURS
BARBITURATES	3-5 DAYS
PHENCYCLIDINE	72 HOURS
LSD	48 HOURS
MORPHINE	48 HOURS

Table 2 Drug Detection Length

From (NDSL 1994)

C. SUMMARY

The Navy's Drug Testing Policy has developed into a very potent weapon in combating drug abuse. Today's policy of "zero tolerance" concerning drug use is enforced by the urinalysis program. According to the Worldwide Survey the drug use rate has fallen from 43 percent in 1980 to 6.6 percent in 1992. This reduction may appear quite good, but there are some alarming figures. The drug use rate for young enlisted personnel is 17 percent and the use among Hispanics is 13 percent. These high values indicate that a more clearly defined drug testing policy might help. One method of achieving a lower drug use rate among young enlistees is to increase the daily probability of detection. The next chapter will show drug testing practices that will increase the probability of detecting a drug abuser.

III. PROBABILITY OF DETECTING A DRUG ABUSER

An alternate model for drug testing is presented in this chapter. This model was developed by Theodore J. Thompson and James P. Boyle of the Navy Personnel Research and Development Center (NPRDC) in San Diego. The chapter is divided into three sections: section A defines the values for the current and alternate models, section B shows various probabilities of detection for different levels of drug abuse using the alternate strategy, the final section compares actual command level probability of detecting a drug abuser against the alternate model's probability of detecting a drug abuser. Costs to the Navy of retaining a drug abuser and the optimum level of drug testing are discussed in Chapter IV.

A. CURRENT AND ALTERNATE DRUG TESTING MODELS

1. Current Model

The current drug testing program utilized by the Navy gives great leeway to Commanding Officers. As previously discussed, the policy requires testing no more than 20 percent of a command each month (OPNAV 5350.4B, 1992). This model, as described by Thompson and Boyle, has four basic assumptions:

1. The testing period is a fixed number of days. Since the Navy's program is conducted on a monthly basis, 30 days is used as the testing period. The model, though, considers the general case with the size of the testing period any fixed value.
2. A simple random sample of days is drawn from the set of days in the testing period. The observed size of this sample is usually one, with occasional values as high as four or five.
3. On each of the days sampled, a simple random sample of people is drawn from the total population of members at a given command. Thus, a command desiring to test 20 percent may sample 20 percent 1 day each month, or 10 percent twice a month, and so forth.

4. A member has drugs detectable in their system for some fixed number of days during the testing period. Based on these assumptions the probability of detection of a drug user during a single testing period can be developed. (Thompson, 1992)

Thompson and Boyle compute the probability of detecting drugs with the following formulas.³ The probability of detecting drugs is represented by $Pr(DET)$. The number of simple random sample days is expressed by K . The number of total days within the period is expressed by M , while the number of days within M that drugs can be detected in a person's urine is denoted by m . The population is represented by N and the simple random sample size is shown by $n_1 + n_2 + n_3 \dots n_k = n$. The number of days during M that a drug test is administered (K) and drugs are present within urine (m) is denoted by Z . If all n_i are equal and Z equals a particular value, then $Pr(DET)$, is:

$$Pr(DET|Z=k) = 1 - \left(1 - \frac{n}{KN}\right)^k \quad (1)$$

The probability distribution of Z is hypergeometric:

$$Pr(Z = k) = \frac{\binom{m}{k} \binom{M-m}{K-k}}{\binom{M}{K}} \quad (2)$$

Therefore:

$$Pr [DET \cap (Z = k)] = \left[1 - \left(1 - \frac{n}{KN}\right)^k\right] \frac{\binom{m}{k} \binom{M-m}{K-k}}{\binom{M}{K}} \quad (3)$$

³ Explanation and proof of the model's formulas are provided for technical reference. It is not necessary to understand the formulas in order to understand the results.

and

$$Pr (DET) = \sum_{k=\max(0, m-M+K)}^{\min(m, K)} \left[1 - \left(1 - \frac{n}{KN}\right)^k\right] \binom{m}{k} \binom{M-m}{K-k} / \binom{M}{K} \quad (4)$$

The values found in Table 3 were produced using formulas 1-4. The probability of detection is based on a gaming drug user (a drug use pattern designed to minimize detection). The probability of detecting drugs decreases (slightly) as the number of testing days increases, for a given value of n. As a given number of samples is spread over more testing days the probability of detecting a current user decreases. However, the probability increases as the number of samples increases, given k. Logic dictates that as the number of testing days decreases the number of days available for risk free drug abuse increases. In fact, Thompson and Boyle show this in Formula 5. Drug users control their drug use until after the last day of testing. They also control their usage so that drugs are in their system for m days or the days remaining in the month, whichever is less. Equation 5 assumes drug abusers know the number of days that drug testing occurs. As the number of testing days increases the expected of drug use decreases.

$$\begin{aligned} E(y) &= \sum_{j=0}^{M-K} Pr(T_K = M-j) \min(m, j) \\ &= \sum_{j=0}^{M-K} \left[\binom{M-j-1}{K-1} / \binom{M}{K} \right] \min(m, j) \end{aligned} \quad (5)$$

TESTING DAYS (K)	DRUG USAGE DAYS (m)	PR(DET) 20% SAMPLING	PR(DET) 10% SAMPLING
1	3	.0200	.0100
5	3	.0199	.0100
15	3	.0199	.0100
30	3	.0199	.0100
1	9	.0600	.0300
5	9	.0587	.0297
15	9	.0585	.0296
30	9	.0585	.0296
1	30	.2000	.1000
5	30	.1846	.0961
15	30	.1824	.0955
30	30	.1818	.0953

Table 3 Pr(DET) With Various Detection Rates and Usage Rates
After (Thompson, 1992)

Table 4 is developed using Equation 5. The expected drug use days increases as m increases for a given K . If a drug test (K) is administered once in a 30 day period, then a gaming drug user can minimize detection by abusing drugs for an average of 14.5 days in each period. If drug tests are given 30 times during a period, and the possible drug usage period is $M = 30$, then the abuser would not use drugs. Thus, the number of drug usage days will decrease as the number of testing days increases.

K	m = 3	m = 9	m = 30
1	2.800	7.500	14.500
5	2.089	3.786	4.167
15	.853	.937	.938
30	.000	.000	.000

Table 4 Expected Drug Usage Days Using Gaming ($M=30$)
After (Thompson, 1992)

Figure 7 is derived from the $m = 30$ column, in Table 4 (30 possible drug usage days within a period). Controlling the level of drug use or "gaming" can produce a detection probability of zero. Therefore, an alternate method of drug testing should be implemented. This alternate method should maintain at least the current level of detection probability and should lead to decreased levels of drug use.

2. Alternative Model

The alternative model for drug testing was also developed by Thompson and Boyle. The basic assumptions of the original model are used in the new model, with one slight change to assumption two:

1. The testing period is a fixed number of days.
2. Testing is conducted on each day in the testing period with some fixed probability.
3. On each of the testing days, a simple random sample of people is drawn from the total population of members at a given command.
4. A member has drugs detectable in their system some fixed number of days during the testing period. (Thompson, 1992)

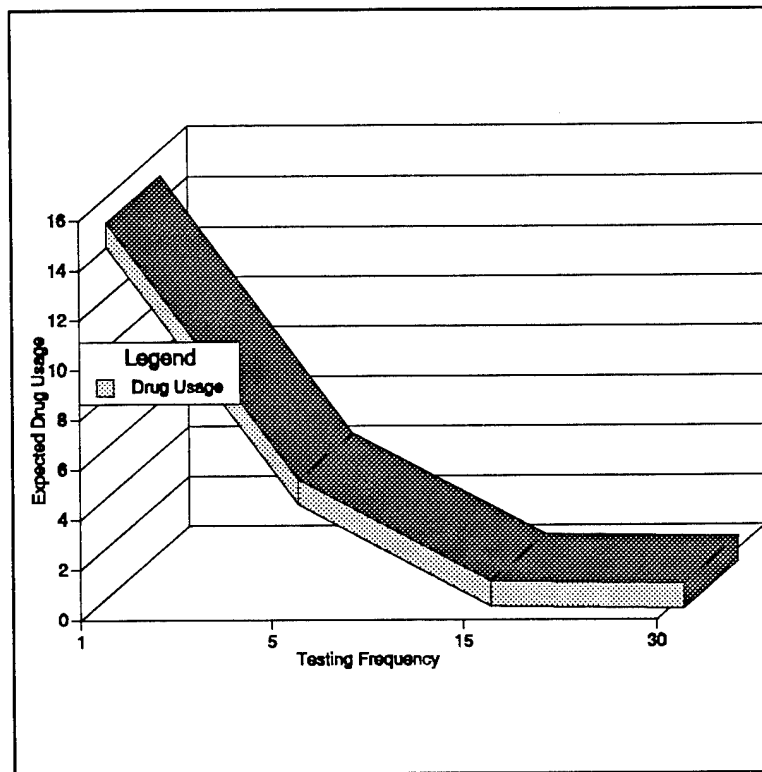


Figure 7 Expected Days of Drug Usage ($M=30$)
After (Thompson, 1992)

Thompson and Boyle prove the alternative model does not randomly select a fixed K from the testing period M . Testing is conducted on each day in the period with n the sample size, remaining constant during each K . Therefore, r_i is the sampling fraction on the i th day. If the probability of testing on a specific day is constant, then K has a binomial distribution with parameters K/M and M . Let $Z_i =$

1 if testing occurs and drugs are present. Let $Z_i = 0$ if testing occurs and drugs are not present. Z is the total number of testing days when users have drugs in their system:

$$Z = \sum_{i=1}^M Z_i \quad (6)$$

Z has a binomial distribution with parameters K/M and m :

$$Pr(Z=z) = \binom{m}{z} \left(\frac{K}{M}\right)^z \left(1 - \frac{K}{M}\right)^{(m-z)} \quad (7)$$

for $z = 0, 1, \dots, m$.

Assume r_i are equal:

$$Pr(DET|Z=z) = 1 - (1-r)^z \quad (8)$$

Therefore:

$$Pr(DET) = \sum_{z=0}^m [1 - (1-r)^z] \binom{m}{z} \left(\frac{K}{M}\right)^z \left(1 - \frac{K}{M}\right)^{(m-z)} \quad (9)$$

Using the binomial theorem Thompson and Boyle developed Equation 10:

$$Pr(DET) = 1 - \left(1 - \frac{rK}{M}\right)^m \quad (10)$$

or

$$P(DET) = 1 - (1 - \frac{n}{NM})^m \quad (10)$$

To calculate the probability of detecting a drug user Equation 10 is used in the DPAS software developed by NPRDC.

B. ALTERNATE MODEL'S PROBABILITY OF DETECTION

1. Gaming Drug Abuser

The Drug Policy Analysis System (DPAS) is used to determine the probability of detecting a drug abuser. A number of drug use patterns or drug testing patterns can be imputed. Various drugs can also be chosen: marijuana, cocaine, amphetamines, methamphetamine, barbiturates, LSD, and morphine. The drug wear-off or detection time (how long drugs can be detected in urine) reflect the values found in Table 2.

Table 5 summaries these input variables under four scenarios. These values are obtained assuming the drug abuser is "gaming." In these scenarios, gaming is defined as using drugs when the probability of detection is low. The average months to detection and the average number of drug tests a person will take before drugs are detected are also listed. All four scenarios assume a command tests the full 20 percent allowed under the current instruction (OPNAV 5350.4B, 1990). Using the alternate testing model, commands test one percent of the population on all 20 workdays per month or period (The DPAS program defaults to a 28 day month or period with 20 workdays per month). Therefore the probability of being selected on any one of the testing days is .01. In scenario one, the drug of choice is marijuana which has a five day wear-off period. The drug abuser is assumed to "game" the drug testing program. In this scenario the drug user abuses drugs on Friday, after the urine test, and on Saturday, when no test is given. Thus, drugs are used eight times per month. The average months to

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
TESTING RATE	20%	20%	20%	20%
TESTING FREQ	20	20	20	20
PROB OF BEING TESTED	.01	.01	.01	.01
DRUG/ WEAR-OFF	MARIJUANA 5 DAYS	MARIJUANA 5 DAYS	COCAINE 2 DAYS	COCAINE 2 DAYS
DAYS OF DRUG USE	8 FRI/SAT	4 FRIDAY	8 FRI/SAT	4 FRIDAY
AVERAGE MONTHS TILL DET	6.2368	8.3097	24.8929	WILL NOT BE DETECTED
AVERAGE TEST TILL DET	1.7473	2.1605	5.4743	WILL NOT BE DETECTED

Table 5 Alternate Models Testing Scenarios

After (DPAS, 1992)

detection for a drug abuser under these constraints is 6.2368. The average number of urine tests a drug abuser will take prior to detection is 1.7473.

In scenario two, the number of drug use days decreases to four per month. The gaming drug abuser chooses to use marijuana only on Fridays, after the urine test. The remaining values are the same as found in scenario one. The average months to detection increases to 8.3097 and the average number of urine tests before detection jumps to 2.1605. This increase is explained by the decrease in the intersection of the total days where both drugs are detectable in the urine (m) and drug testing occurs (K).

Scenario three introduces a new drug: cocaine. Again, the drug abuser uses drugs on Friday and Saturday for a total of eight days of abuse per month. The wear-off period for cocaine is two days. The intersection of m and K decreases due to a shorter wear-off interval. The average months till detection rises to 24.8929. The average number of urine tests administered prior to detection doubles to 5.4743.

The values for scenario four have been changed to reflect a gaming drug abuser that has beat the system. Drug testing remains at the 20 percent level. The testing frequency is 20 days per month and the probability of being tested remains .01 during each of the testing days. But, the drug abuser only uses drugs four times a month in this scenario. Each occurrence is on Friday, after the urine test is given. Recall, the wear-off period for cocaine is two days. Therefore, the intersection of the number of days drugs are present in the urine and drug testing days is zero. Under these conditions a drug abuser will never be caught.

The DPAS program also provides a survivability rate over months. Figure 8 shows these rates for a drug abuser following scenario one. The survivability values for scenarios two and three closely resemble the values in Figure 8, they are not listed. The survivability rate for scenario four is also found in Figure 8. Due to effective gaming, the survivability rate in scenario four is a constant 1.0 throughout the period. The survival rate for scenario one is much different. Figure

8 shows that at month zero the drug abuser has a 1.0 chance of remaining undetected. By the fifth month the rate has fallen to .4475, by the tenth month the survivability rate has decreased to .2003, by the fifteenth month the rate has dropped to .0896, and the twentieth month rate decreased to .0471.

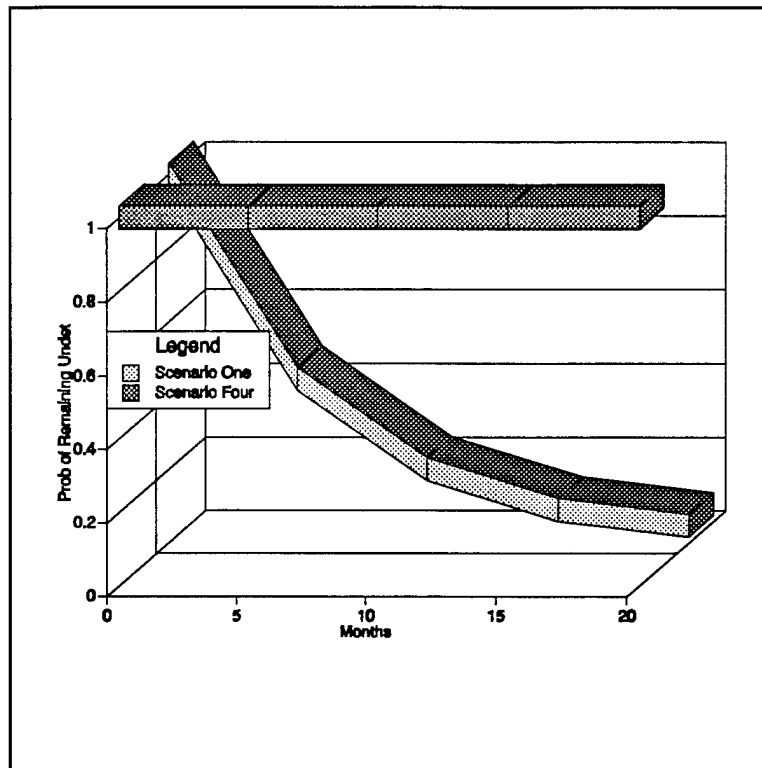


Figure 8 Survivability Rates
After (DPAS, 1992)

2. Non-Gaming Drug Abuser

The DPAS program computes the probability of detection and the average months till detection for a non-gaming drug abuser. A non-gaming drug abuser is defined as one who uses drugs with equal probability at any time, regardless of the probability of detection. A non-gaming drug user can be "lucky" and never be detected abusing drugs or can be detected on the first urinalysis. Each drug use scenario using the alternate method of urinalysis testing produces a different detection time. It is intuitively obvious that the alternate method of drug testing also reduces the detection time for non-gaming drug abusers.

C. ACTUAL COMMAND LEVEL VS ALTERNATE MODEL'S PR(DET)

1. Single UIC

The Drug Information Presentation Manager (DIPM) program presents Navy wide, major claimant, type commanders, and command level drug testing frequencies. In order to show how the alternate model can affect a single command's drug testing program, one UIC was selected as an example. One month was selected to highlight the differences between current policy and the alternate model. This command and this month may not reflect the "average" command's drug testing policy. But, it is an excellent example of how the current policy, prescribed in OPNAV 5350.4B, is wholly inadequate.

Table 6 compares the alternate model and the current policy. Scenarios one and two show a gaming marijuana user under the alternate testing policy. In scenario one, drugs are used eight days per month; in scenario two, they are used four times per month. The testing rate, testing frequency, probability of being tested, drug/wear-off rate, drug usage days, average months till detection and average test till detection are identical to those values found in Table 5 scenarios one and two. Scenarios five and six use the current policy model. Drug use patterns in scenarios one and five are comparable as are drug use patterns in scenarios two and six.

Scenario five has a testing rate of 20 percent each month.⁴ The testing frequency is eight days. For this particular month, the UIC tested only on Saturdays and Sundays. The probability of being tested is .01 on Saturday and .04 on Sunday. Eighty percent of the tests were conducted on Sundays. The drug of choice is marijuana with a wear-off rate of five days. Scenarios five and six continue to assume the drug abuser is "gaming." In scenario five the drug abuser

⁴ The testing rate of 20 percent assumes the UIC chose to test at the maximum rate during the month selected. The testing frequency is therefore derived from a 20 percent testing rate. A testing rate of less than 20 percent would increase the average months till detection.

	SCENARIO 1	SCENARIO 2	SCENARIO 5	SCENARIO 6
TESTING RATE	20%	20%	20%	20%
TESTING FREQ	20	20	8	8
PROB OF BEING TESTED	.01	.01	.01/.04	.01/.04
DRUG/ WEAR- OFF	MARIJUANA 5 DAYS	MARIJUANA 5 DAYS	MARIJUANA 5 DAYS	MARIJUANA 5 DAYS
DAYS OF DRUG USE	8 FRI/SAT	4 FRIDAY	8 SUN/MON	4 SUNDAY
AVER MONTHS TILL DET	6.2368	8.3097	24.8929	WILL NOT BE DETECTED
AVER TEST TILL DET	1.7473	2.1605	5.4657	WILL NOT BE DETECTED

Table 6 Comparison Scenarios

After (DPAS, 1992)

uses drugs eight days a month; on Sunday after the urinalysis and on Mondays. The average months till detection is 24.8929. This value is four times greater than the value found in scenario one. The average test till detection is 5.4657. Again, this value is approximately four times greater than the values found in scenario one.

Scenario six also assumes a testing rate of 20 percent. The testing frequency is eight days per month. Urinalysis was conducted on Saturdays and Sundays. The majority of the tests were again conducted on Sundays. The drug of choice is marijuana with a wear-off rate of five days. As in scenario two, the abuser uses drugs four days a month. This time on Sunday after the drug test is given. Following these constraints the drug abuser is never detected. Under scenario two, the abuser is detected on average in 8.3097 months.

The survivability rates found in Figure 9 are for a drug abuser following scenarios one, five and six. The drug abuser under scenario six will have a survivability rate of one; the abuser will never be detected. The drug abuser in scenario five has a survivability rate of .8179 after five months, .669 after 10 months, .5472 after 15 months, and .4475 after 20 months. These values are higher than the survivability rates found in scenario one. Recall, an abuser under those conditions had a survivability rate of .4475 after five months, .2003 after 10 months, .0896 after 15 months, and .0471 after 20 months.

Of course this single UIC did not follow the same drug testing pattern in subsequent months. It is assumed that a "gaming" drug abuser consumes illegal drugs during periods when he perceives the probability of detection is low. This one example illustrates the hazed approach of the current system.

2. Aggregate Level

Taken as a whole, the Navy's urinalysis testing frequency appears on solid ground. The Navy's testing frequency for FY91 is shown in Table 7. In FY91 the Navy administered approximately 100,000 urine tests (DIPM, 1992). This includes random and all other samples. The Navy conducted 17 percent of the urinalysis

on Mondays, 20 percent on Tuesdays, 17 percent on Wednesday, 16 percent on Thursday, 12 percent on Fridays, 11 percent on Saturdays, and seven percent on Sundays (DIPM, 1992). If approached from the aggregate level, the Navy appears to use the alternate model for drug testing. But, individual commands results prove the alternate method is not utilized.

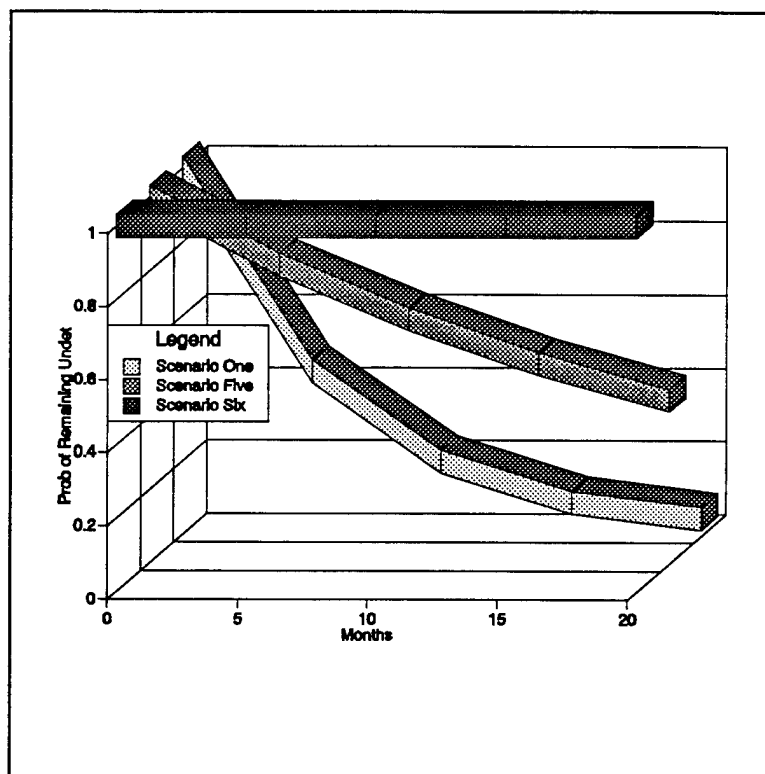


Figure 9 Comparison Survivability Rates After (DPAS, 1992)

	MON	TUES	WED	THUR	FRI	SAT	SUN
%	17%	20%	17%	16%	12%	11%	7%

Table 7 Aggregate Level Testing Frequencies After (DIPM, 1992)

Chapter IV presents the optimum level of drug testing to minimize the cost of drug abuse to the Navy.

IV. TOTAL COST OF DRUG USE

A model showing the total cost to the Navy of drug use is presented in this chapter. This model does not identify actual costs, but points out the relative costs of drug use compared at different levels of drug testing, education, addiction, costs of separation/replacement and social standards. This chapter will primarily address the relative costs to the Navy of drug abuse as it relates to drug testing. Other variables are generally held constant. The chapter is divided into three sections: section A introduces the Total Cost of Drugs Model (TCD) and describes the components of the model, section B shows various percentage levels of testing associated with drug testing effectiveness, section C compares total costs to the Navy of maintaining a testing program that drives drug abuse to zero (virtually impossible) to the total costs to the Navy of maintaining a drug testing program that minimizes the costs at some acceptable level of drug abuse.

A. TOTAL COST OF DRUGS MODEL (TCD)

The TCD, developed by Dr. William Gates, shows how certain variables affect the costs of drugs to the Navy. The model is presented in Equation 11.

$$TCD_t = (A_t - D_t) C_u + D_t * C_s + N_t (F_t^T * C_t + F_t^E * C_E) \quad (11)$$

This thesis is primarily concerned with drug testing, represented by F_t^T . The number of drug addicts or the number of drug users is represented by A_t . The number of drug users detected is shown by D_t . These two values are considered measurable to the extent needed for this calculation. The cost of undetected drug use is symbolized by C_u . This value is not easily measured. Although the value of C_u is held constant for the purpose of this study, the cost of undetected drug use is conjectural. The symbol C_s represents the cost of separation and replacement. This value is also difficult to measure and is held at some constant rate for the

purpose of this study. The force size or population is represented by N_t . The frequency of drug testing, measured in percentage of the total force, N_t , is shown by F_t^T . The frequency of drug education, measured in percentage of N_t , is represented by F_t^E . The unit of time for testing and education is normally equal to a month. The cost of the drug test and drug education per capita is shown by C_t and C_e , respectively.

The frequency of testing plays a more important role in the development of the TCD than is seen at first glance. The number of drug users is found by multiplying the addiction or drug use rate by N_t : $A_t = a_t * N_t$. The drug use rate is a function of social norms, detection rate (d_t), and education efforts. In turn detection rates are a function of testing rates and effectiveness. A similar fact arises when breaking down the components of D_t . The number of drug users detected, D_t , is found by multiplying the number of addicts by the detection rate: $D_t = d_t * A_t$. As stated above, the detection rate is a function of testing rates and effectiveness. Therefore, as drug testing and effectiveness varies so will the number of drug users, the user or addiction rate, the number of detected drug users, the detection rate and the total cost of drugs to the Navy.

The central relationship and pivotal role that drug testing plays in the costs of drug use to the Navy suggest that testing alone could possibly reduce the number of drug users to zero. Section B explores that possibility.

B. DRUG TESTING EFFECTIVENESS

1. Effectiveness Definition

The drug detection rate is a function of the drug testing frequency. Intuition says that as the testing frequency increases the detection rate should also increase. This is true, but another variable must be introduced in order to understand the relationship between D_t and the level of testing; that variable is

testing effectiveness (B):

$$d_t = B * F_t^T * a_t \quad (12)$$

Gaming was introduced in Chapter III. It was assumed that drug users will game or use drugs on the days when they perceive the probability of detection to be low. As gaming increases the effectiveness of drug testing will decrease. Because drug testing plays such a pivotal role in the TCD model, it is easy to see that as the effectiveness of drug testing varies so will the other components.

2. Testing Examples

If DoD's objective is to select the drug testing and education frequencies to minimize the total cost of drug use, the optimal policy depends on the effectiveness of drug testing. Table 8 shows how the effectiveness of drug testing relates to various components of the basic TCD model (Equation 11). In this illustration, the costs of undetected drug use to the Navy (C_u) and the costs of separation and replacement (C_s) are held constant at a fixed level of 10 units.⁵ The costs of training (C_t) and the costs of education (C_e) are held at one unit. The population size (N_t) is 1000 persons. The effectiveness of drug testing is represented by B .

Given this models structure and parameter values, if the measured effectiveness of the testing program is .79, that is 79 percent of the drug users that are tested are detected, then drug testing is not a viable deterrent to drug use. If DoD wants to minimize their total drug costs, the optimal level of testing would drop to zero and education would increase to reduce the drug use rate (a_t). The total costs of drugs to the Navy slowly declines as the level of testing effectiveness increases. Recall, the total cost of drugs to the Navy is a relative value. It is used to compare levels of testing, education and costs of these activities and how they

⁵ The term unit can mean dollars or any other measure of cost.

relate to the overall costs of drug use. As the level of drug testing effectiveness B increases, the optimal frequency of testing increases. As testing becomes more influential the need for drug education decreases. Due to the controlling relationship of drug testing in regards to drug use rates and drug use levels, these values will drop as B increases. On the reverse side, as effectiveness improves (or gaming decreases) the detection rate and the total number of drug users detected will rise.

B	.79	.84	.89	.90	.94	1.00
F_t	.00	.10	.19	.21	.27	.35
F_e	.63	.60	.56	.56	.53	.50
a_t	.13	.12	.11	.11	.11	.10
d_t	.00	.09	.17	.19	.25	.35
A_t	125	119	112	111	106	99
D_t	.00	10.12	19.30	20.95	27.00	34.69
TCD	1889	1886	1878	1876	1865	1846

Table 8 Drug Testing Effectiveness and the Cost Minimizing Testing Policy After (Gates, 1994)

Figure 10 is a graphic representation of drug testing effectiveness as it relates to the number of drug users and the number of users detected. Again, as effectiveness increases the number of users decreases and the number of drug users detected increases. When drug testing is 100 percent effective, the number of drug users is approximately 100. Table 8 and Figure 10 show that if testing is 100 percent effective (no gaming) random urinalysis detects all drug users that

were tested. But, even at this level of effectiveness and high percentage of the population tested, drug use will not be eliminated. Recall, A_t is also a function of social variables.

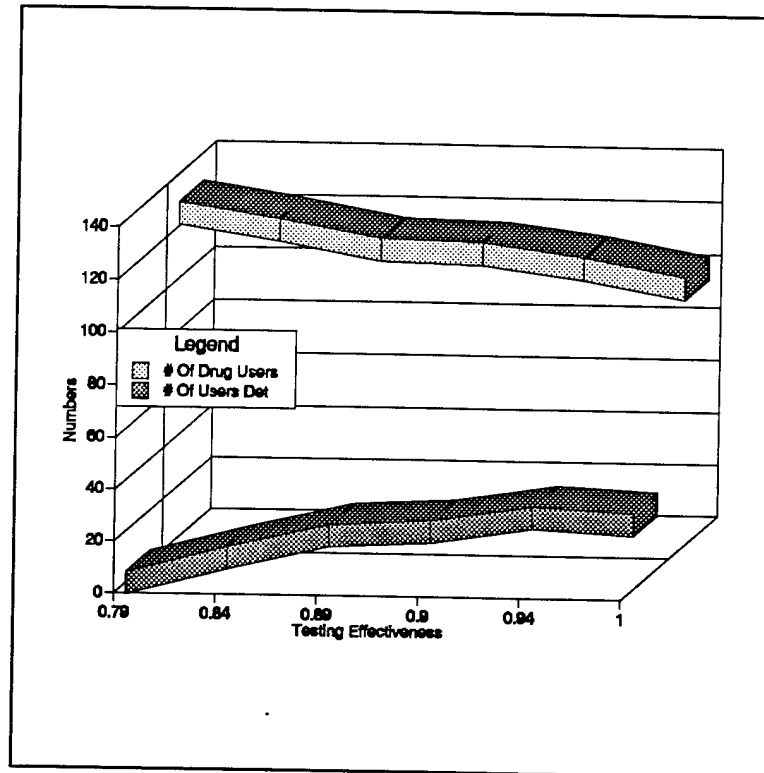


Figure 10 Drug Testing Effectiveness
After (Gates, 1994)

C. MINIMUM COSTS VERSUS ZERO DRUG USE

1. Minimum Costs

Under certain conditions, the TCD curve has a minimum point. Using the same parameters found in Section B, the minimum total costs of drugs is found when the F_t is 35 percent. The relevant parameter values are: costs of undetected drug use and of separation/replacement are both 10 units, the costs of both testing and education are 1 unit, N equals 1000, and the testing effectiveness is one or 100 percent effective.

Figure 11 graphs the TCD curve. The minimum point for total costs is reached at 1847 units when F_t is 35 percent. Beyond this testing level, the test becomes too costly for the return. Specifically, testing has driven drug use rates low enough that the cost of detecting an additional drug user is more than the cost of undetected drug use. Thus, additional testing increases total drug costs. A minimum situation will likely occur regardless of the structure or parameter values in the TCD model.

The illustration in Section B found that drug testing alone will not drive drug use to zero. But, for comparison reasons the TCD model can be manipulated to reflect zero drug abuse stemming from drug testing.

2. Zero Drug Use

By itself, drug testing cannot drive drug use to zero in the example illustrated here. However, the TCD model can simulate a zero use pattern. This simulation is used for comparison. In order to compare the total costs of zero drug use and the minimum total costs the same parameter values are assumed: the cost of undetected drug use and the costs of separation/replacement are 10, the costs of both drug education and testing are one, and $N = 1000$ persons. By maintaining these parameters at a constant rate, the testing frequency is increased to over 2.5. This value indicates that over 250 percent of N is tested during the period.

With this extreme testing policy, DoD's detection rate exceeds its drug use rate. This is interpreted as follows. During the period everyone is tested an average of 2.5 times. Personnel replacing those separated for drug use (maintaining $N = 1000$) have the same probability of using drugs as the previous population, and some of them may be detected during the same period. Even this extreme level of testing does not reduce drug use to absolute zero in this illustration.

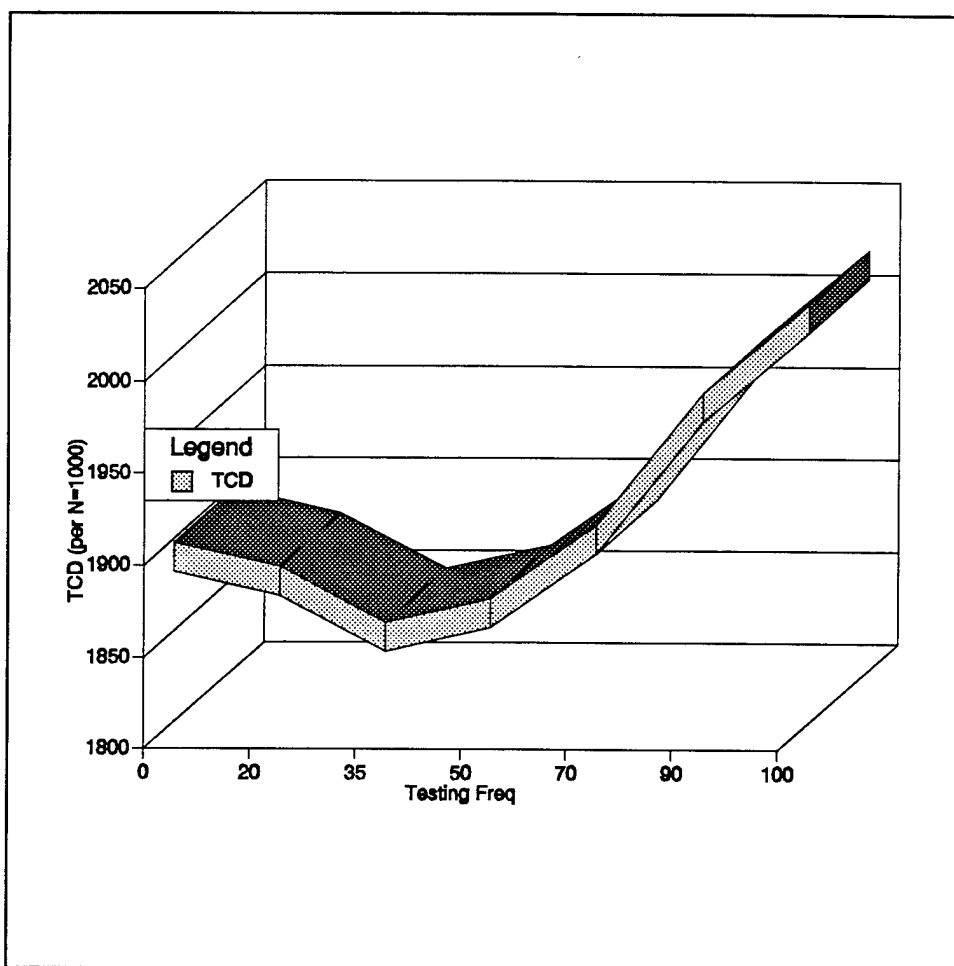


Figure 11 TCD After (Gates, 1994)

Figure 12 shows the total costs curve under this hypothetical simulation. Of course the curve continues the TCD curve found in Figure 11. The point of this graph is to show at the margin how rapidly the total costs increase as DoD tries to eliminate all drug use.

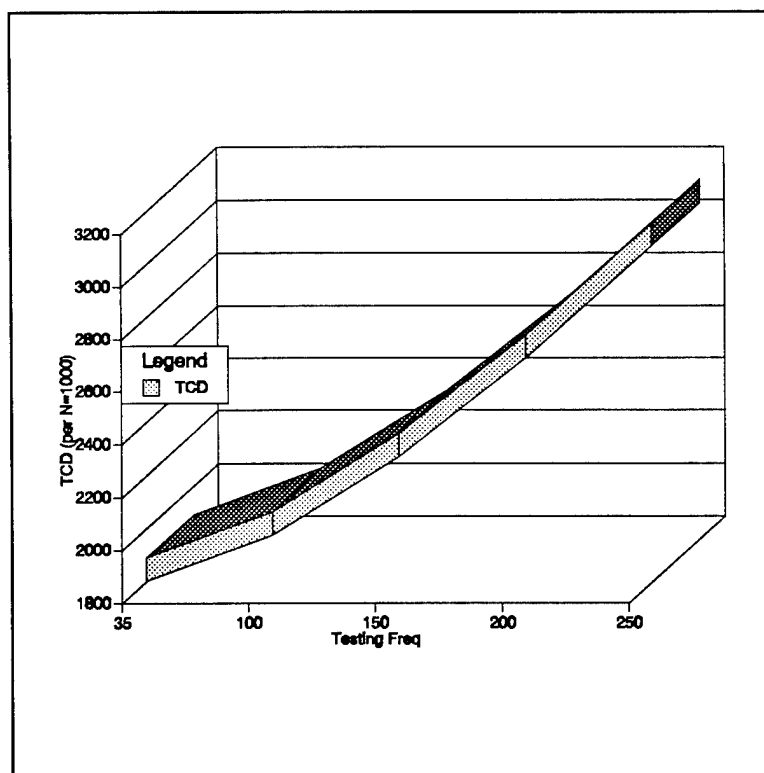


Figure 12 TCD at Zero Drug Use
After (Gates, 1994)

Figures 11 and 12 suggest, at least financially, some level of drug use is acceptable. One component of the TCD model that has purposely been neglected is the frequency of training (F_t^E). Training is a substitute for testing. As one increases, the other can decrease while maintaining a desired level of deterrence.

V. CONCLUSIONS AND RECOMMENDATIONS

The primary research question in this thesis is: "How will changes in the Navy's Drug Testing Policy affect the probability of detecting a random or gaming drug user." The secondary questions were: "How will the total cost of drug use be affected by changing the drug testing policy and how would proposed policy changes affect actual command level testing policies." This thesis shows that changes are possible and how they affect cost.

For the past two decades the Navy has pushed for a drug free work place. Numerous training and education programs were implemented. These efforts were designed to increase the awareness of the negative effects of drug use and thereby decrease the level of drug abuse. Some success was seen from these programs, but high drug use levels continued. Slowly, the Navy turned to drug testing as the primary means of detecting and deterring drug users.

In the 1980 Worldwide Survey, the Navy's self reported drug use for the past 12 months was an astronomical 43 percent. Over 17 percent of the force reported suffering serious negative effects from drug abuse. Productivity loss was reported by 11 percent of the force. These values represented the Navy prior to establishing a thorough anti-drug urinalysis testing program. Once the urinalysis testing program became a Navy wide standard, drug use declined.

In the latest Worldwide Survey (1992), self reported Navy drug use was approximately seven percent. Productivity loss and serious negative effects caused by drug abuse fell to less than one percent. The drug use trend dropped significantly, due mainly to the testing program. Although the level of use Navy wide is less than 10 percent, there are some alarming levels of continued drug use.

In the 1992 Worldwide Survey, almost 18 percent of junior sailors (E1-E3) reported consuming drugs. Drug use among teenagers was reported at 16

percent.⁶ Drug use among Hispanics was almost 13 percent and almost 11 percent for unmarried sailors. Taken on the aggregate level the Navy does not appear to have a significant drug abuse problem. But, it is clear a drug problem still exists among particular sub-groups.

In order to further reduce drug use levels and eliminate any tendency toward an upward trend of drug abuse, the Navy should reconsider its drug testing policy. Under the current policy, a gaming drug abuser is less likely to be detected. A simple change in the manner in which drug testing is carried out will increase the likelihood of detecting a gaming drug user. A non-gaming drug user's probability of detection also increases. This research shows the Navy should test more often.

The probability of being tested should remain constant through out the period. Instead of testing once or twice a month, commands should test at least 20 times per month or period. Under this policy, the probability of being tested is .01 each testing day. Testing at this level does not require additional testing facilities, testing personnel or a major change in the overall testing policy. This testing method will improve the effectiveness of the existing program.

The Navy could drive the level of drug use down further by increasing the percent of the population tested each month. However, eliminating drug use through drug testing alone may be impossible or prohibitively expensive. A combination of testing, education and recruit screening may reduce drug use to lower levels for a lower total cost. However, considering the total cost of drug use, some level of drug use maybe acceptable. In the illustration presented here, the total cost of drug use is minimized when the level of testing is 35 percent and the level of drug education is 50 percent. Additional testing and education would further reduce drug use, but the total cost would increase. Eliminating drug use may not be effective.

⁶ A policy of designating certain rates or ages for increased testing may be beneficial in reducing drug use, but could run into legal problems. This avenue of testing is not presented in this research.

Bottomline; the Navy continues to have a drug abuse problem. The current testing policy does not maximize the effectiveness of the testing program because it encourages gaming. To minimize gaming and maximize the effectiveness of testing, the Navy should test at least 20 percent of the force per month and test at least 20 days per month.

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